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APPLICATIONS OF DECISION ANALYSIS TO THE U.S. ARMY AFFORDABILITY STUDY

DECISIONS AND DESIGNS INCORPORATED

Dennis M. Buede
Michael L. Donnell
Janice E. Ragland
Edward G. Rapp

June 1978

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The University of Southern California

Inquiries and comments with regard to this report should be addressed to:

Dr. Martin A. Tolcott
Director, Engineering Psychology Programs
Office of Naval Research
800 North Quincy Street
Arlington, Virginia 22217

or

Dr. Stephen J. Andriole
Cybernetics Technology Office
Defense Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, Virginia 22209

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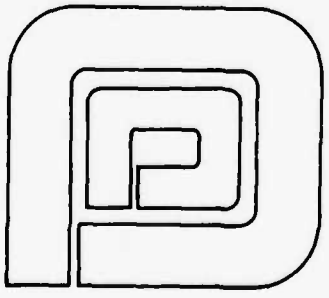

DECISIONS and DESIGNS, INC.
Suite 600, 8400 Westpark Drive
P.O.Box 907
McLean, Virginia 22101
(703) 821-2828

SUMMARY

This report describes several applications of decision analysis to the Army's Affordability Study. These applications are focused on the allocation of resources to support the requirements, concepts, and plans of the Army. The purpose of these applications is to establish a rigorous methodology to assist the decision makers in allocating resources.

Decision analysis is a quantitative procedure for the systematic evaluation of the alternatives available to a decision maker. The process defined as decision analysis is to decompose a decision problem into clearly defined components, so that all options, outcomes, values, and probabilities are depicted. The explicit representation of the decision not only provides a recommended course of action, but also facilitates communication among those involved. So, it should be emphasized that decision analysis does not replace decision makers but structures the role of wise human judgment in the decision process.

The first application of decision analysis is the use of cost-benefit analysis to prioritize the Army program and budget decision units. This process involves quantifying the relative benefits and costs of each decision unit. Since the purpose of the prioritization is to determine the allocation of money to a discrete number of decision units, the quantification of benefit is done according to an Army mission value system, not according to a monetary value system.

The benefits are judgmental assessments, obtained by first quantifying the relative benefits of programs within the areas of each sponsor (e.g., operations, personnel) and

then determining the relative benefits of selected programs from each sponsor's list. Once the benefits have been quantified, the decision units can be prioritized from the most cost-beneficial (benefit per dollar) to least cost-beneficial. This procedure has been applied to the prioritization of 334 Program Analysis Resource Review (PARR) issues and 185 Program Development Incremental Packages (PDIP) in the POM 80-84 development. The same process will be used in the budget preparation during August and September. In both cases so far, the decision-analytic process provided a very useful starting point from which issues could be determined and discussed by the decision makers.

Multi-attribute utility analysis is the second decision analytic technique that will be investigated during this affordability study. A multi-attribute utility model is hierarchical in nature, as the top-level factor in the analysis is successively divided until highly specific characteristics or parameters are detailed at the bottom of the hierarchy. This process will be used in mission capabilities analyses that are directed primarily at ASARC reviews and major issues defense.

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CONTENTS (Con't)

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ABBREVIATIONS

AAD	Army Automation Directorate
ASARC	Army Systems Acquisition Review Council
BRC	Budget Review Committee
CM	Countermeasure
CRRC	Construction Requirements Review Committee
DA	Department of the Army
DCSLOG	Deputy Chief of Staff for Logistics
DCSOPS	Deputy Chief of Staff for Operations
DCSPER	Deputy Chief of Staff for Personnel
DCSRDA	Deputy Chief of Staff for Research, Development, and Acquisition
EUR-KOR	European and Korean
FEBA	Forward Edge of the Battle Area
MAA	Mission Area Analysis
MACOM	Major Command
MAUA	Multi-Attribute Utility Analysis
NGB	National Guard Bureau
OCAR	Office of the Chief of Army Reserve
OCE	Office of the Chief of Engineers
OSD	Office of the Secretary of Defense
OTSG	Office of the Surgeon General
PAE	Program Analysis and Evaluation Directorate
PA&ED	Program Analysis and Evaluation Directorate
PARR	Program Analysis Resource Review
PDIP	Program Development Incremental Package

ABBREVIATIONS (Con't)

PGRC	Program Guidance Review Committee
PIN	PARR Issue Narrative
POM	Program Objective Memorandum
RDAC	Research, Development, and Acquisition Committee
SIPC	Stationing and Installations Planning Committee

1.0 INTRODUCTION

The purpose of this report is to describe several applications of decision analysis to the U.S. Army's Affordability Study, which is being undertaken by the Program Analysis and Evaluation Directorate (PAE), Office Chief of Staff Army. This Affordability Study has been prompted by the recognition that in the current technological explosion opportunities exceed resources to exploit. The central question is: How do we modernize, maintain readiness, enhance sustainability, develop human commitment, . . ., to meet the threat of the 1990's, given 3% real growth? That is, the U.S. Army must maintain and program the most effective fighting force for the future within very clear-cut budgetary constraints. To do this, the relative merits of all Army programs must be compared. The Army has begun to develop the tools and disciplines needed to answer questions about the marginal mission benefit of individual programs in order to develop a means of prioritizing competing issues.

The Army's Affordability Review Program attempts to offer decision makers a rational means of responding to these new management challenges. The Army uses the term "affordability" to describe efforts within the Army Staff to develop and apply the tools and disciplines required to measure and then to evaluate marginal costs and mission benefit. The efforts stem from the realization that an initiative may be cost-effective yet not affordable. An affordability analysis, then, is an investigation of the effects of constrained resources on alternative Army programs. The objective of such analysis is to maximize combat capabilities within a projected level of resource constraints. Until now, affordability decisions were made almost intuitively, given the absence of a systematic and disciplined effort to assess the full impact of a program on the planning,

programming, and budgetary continuum. The applications of decision analysis described in this report are part of these affordability analyses.

The primary problem addressed by these decision-analytic applications is the current lack of a defined basis (methodology with analytic rigor) to assist decision makers in determining the proper allocation of constrained dollar resources among competing Army programs in support of the Army's requirements, concepts, and plans. Therefore, the purpose here is to provide the Army an explicit and documented basis for allocating constrained resources among competing requirements, concepts, and plans. To accomplish this, there are three objectives:

1. Determine whether decision analysis can be applied in a rigorous way in the Army's existing resource allocating process.

2. Develop an Army procedure for prioritizing decision units across appropriations.

3. Evaluate the utility of the technique for prioritizing the allocation of resources among alternative requirements, plans, concepts, strategies, and programs given fiscal, manpower, and time resource constraints.

In order to be successful, any prioritization procedure must include:

- uniform rationale for identifying program packages;
- values based on the mission goals;
- functional (multi-appropriation) program packages;
- a funding strategy for various fiscal constraints; and

- documentation of the process.

The rationale for defining program packages to be considered for funding should be open and common to all proponents. The relative values for these packages should be based on the Army goals, with other factors to be considered as a deviation from the prioritization. The proponents, and therefore the program packages, should be based on functional, not appropriation, categories. The prioritization process should result in a funding strategy for a number of fiscal constraints that might be imposed by the Office of the Secretary of Defense (OSD). Finally, the process should be documented and reproducible.

Section 2.0 of this report describes decision analysis and the methodologies used in these applications. The first methodology addresses the prioritization of decision units directly by quantifying their relative benefits and by using the cost-benefit criterion to prioritize. Multi-attribute utility theory is the second methodology that can be used to analyze the relative capabilities of the Army within missions. This is an indirect link to the prioritization problem because it will provide a framework that will be very useful in the quantification of the relative benefits for the decision units in the first application.

Section 3.0 discusses the application of the first methodology to the prioritization of the Program Analysis Resource Review (PARR), the 1980 Program Objective Memorandum (POM-80) decision units, and the decision units of the 1980 budget. Section 4.0 will document (when published) the application of multi-attribute utility theory to the analysis of Army's mission capabilities. Section 5.0 contains a brief discussion of topics related to these two applications. Finally, the conclusions and recommendations are presented in Section 6.0.

2.0 METHODOLOGY--DECISION ANALYSIS

Decision analysis is a quantitative method for the systematic evaluation of the costs or benefits accruing to courses of action that might be taken in a decision problem. It entails identification of the alternative choices involved, the assignment of values (costs/benefits) for possible outcomes, and the expression of the probability of those outcomes being realized. With this information at hand, one can then systematically combine the values and probabilities to show the probable gain or loss that is associated with each alternative choice. Since 1970, there has been a dramatic burgeoning of efforts by defense agencies to adapt this technology to their day-to-day decision making. Many have found it a way to make better, more defensible decisions.

In the application of decision analysis, a problem is decomposed into clearly defined components in which all options, outcomes, values, and probabilities are depicted. Quantification in the form of the value for each possible outcome and the probability of those values (or costs) being realized can be in terms of objective information or in the form of quantitative expressions of the subjective judgments of experts. In the latter case, the quantitative expression serves to make explicit those subjective qualities which would otherwise be weighted in the decision process, albeit in a more elusive, intuitive way.

Beyond its primary role of serving as a method for the logical solution of complex decision problems, decision analysis has additional advantages as well. The formal structure of decision analysis makes clear all the elements, their relationships, and their associated weights that have been considered in a decision problem. If only because the model is explicit, it can serve an important role in facili-

tating communication among those involved in the decision process. With a decision problem structured in a decision-analytic framework, it is an easy matter to identify the location, extent, and importance of any areas of disagreement, and to determine whether such disagreements have any material impact on the indicated decision. In addition, should there be any change in the circumstances bearing upon a given decision problem, it is fairly straightforward to reenter the existing problem structure to change values or to add or remove problem dimensions as required.

It should be emphasized that in no sense does decision analysis replace decision makers with arithmetic or change the role of wise human judgment in decision making. Rather, it provides an orderly and more easily understood structure that helps to aggregate the wisdom of experts on the many topics that may be needed to make a decision, and it supports the skilled decision maker by providing him with logically sound techniques to support, supplement, and ensure the internal consistency of his judgments.

In fact, a decision analyst's objective is to facilitate the decision process by structuring the problem with the decision maker and eliciting the values and probabilities of the decision maker. Thus, the decision analyst is not a surrogate decision maker putting together a study that is presented to the real decision maker upon completion. Rather, he works intimately with the decision-making body to provide them a structure which they can use to reach the preferred decision.

2.1 Cost-Benefit Analysis for Prioritization

Cost-benefit analysis traditionally has two distinct purposes. The first is to determine the appropriateness of undertaking a specific action, such as building a dam or a new

plant, by determining whether the benefits outweigh the costs and the negative side effects. This is generally a difficult undertaking because it is difficult to foresee all the dimensions that are important and to estimate possible outcomes in terms of each dimension. The second purpose is to achieve the most cost-beneficial allocation of a fixed level of resources among a large number of programs. In this case, the application of cost-benefit analysis is more straightforward. Basically, the relative benefits of each program must be quantified and reliable cost estimates obtained. For this type of allocation, the relative benefits of these programs are quantified according to a mission-oriented value system, not a monetary (dollar) value system.

Subjective benefit assessments can be made for very diverse programs by an elicitation procedure that motivates the manager of a set of programs to provide his true subjective estimates. Psychologists and decision analysts have observed that the best way to obtain reliable quantifications of this sort is to use paired comparisons, that is, to ask the expert to make choices between two packages until points of indifference can be found. This elicitation procedure begins with the quantification of benefits for sets of similar programs, each set having the same manager or sponsor who is an expert on their usefulness. Once these benefit scales have been assessed, each manager is asked to provide rationale for the benefit numbers attached to his programs.

The following example is a useful illustration of this procedure. Suppose there are ten possible decision units, designated A through J, ranked ordinally as proposed by the sponsor. These are listed in Table 2-1, along with an initial benefit scale, total cost, and initial benefit/cost ratio. First, the decision unit with the largest benefit/cost ratio is selected, then the order in which the remaining

PROCUREMENTS	INITIAL BENEFITS	TOTAL COSTS	BENEFIT / COST
A	100	16	6.2
B	99	36	2.8
C	95	56	1.7
D	90	9	10.0
E	87	30	2.9
F	83	20	4.2
G	70	35	2.0
H	70	26	2.7
I	60	2	30.0
J	55	1	55.0

Table 2-1

PROCUREMENTS – INITIAL COMPARISONS

units would be prioritized according to the cost-benefit criterion is:

J, I, D, A, F, E, G, H, G, C.

This criterion guarantees that for any budget constraint, the most benefit will be obtained. Figure 2-1 illustrates the difference in benefit between the cost-benefit and benefit-only criteria for all levels of cost. Note that using the cost-benefit criterion with these benefit numbers is almost equivalent to ordering the decision units by cost in descending order.

The second iteration of this process begins by comparing decision units J, I, and D with A. The package J, I, and D costs nearly as much as A but should be twice as beneficial as A. However, when asked which he preferred, the sponsor said A had more benefit than J, I, and D. So A's benefit was adjusted to 250 to reflect the strength of his preference.

Next, note that A and B are nearly equivalent to J, I, D, A, and F in cost. Since A is common to both packages, and there are no interdependencies between the procurements, B can be compared to J, I, D, and F. In this case, J, I, D, and F were strongly preferred, and the sponsor felt B was equivalent to J, I, and D. So B's benefit was raised to 215. In this way, paired comparisons are used to reach a level of indifference.

Through this process, the sponsor develops a concept of a true zero benefit and then scales the relative benefits of his programs between zero and one hundred (assigned to the most beneficial program). The resultant ratio-benefit scale reflects the sponsor's value system.

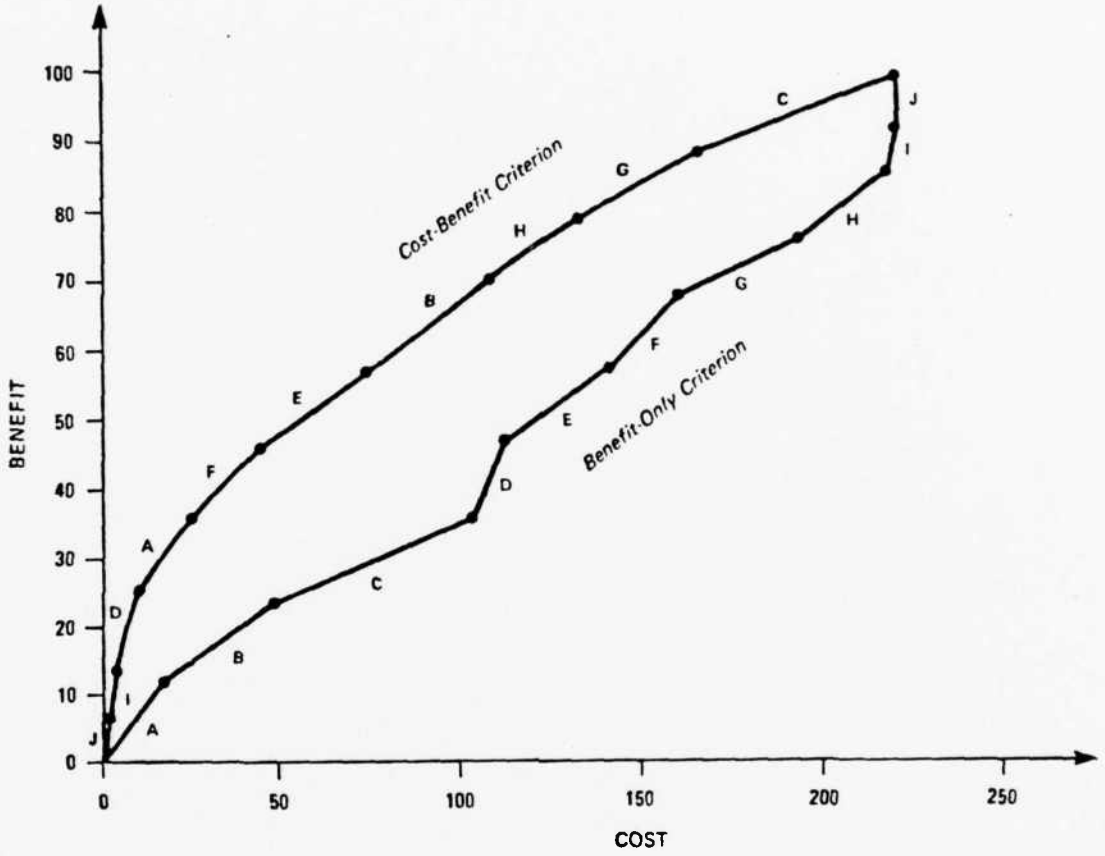

Figure 2-1

COST-BENEFIT VS. BENEFIT-ONLY CRITERIA – INITIAL COMPARISONS

More iterations of the paired-comparisons procedure were made until the sponsor was happy that the benefit numbers reflected his judgment. The normalized scale is presented in Table 2-2. The final order of cost-benefit buys is:

J, I, D, A, B, G, F, C, E, H.

This process helps the sponsor to develop substantive rationale for supporting the final benefit scale because the judgments he has to make require more thought than that typically required to come up with a list from best to worst.

Figure 2-2 shows the final differences between buying with the cost-benefit criterion versus the benefit-only criterion. For a fiscal constraint of $100, the cost-benefit criterion provides 68% of the possible benefit, which is a 33% increase over the benefit-only criterion. Clearly, to use the cost-benefit criterion effectively and to be considered fiscally responsible, the sponsors must spend considerable time producing a good set of benefit numbers with the spread that they believe truly exists between their programs.

After these benefit scales and supporting rationale have been assessed for each sponsor, a group of individuals is formed to provide a benefit scale across the diverse set of decision units formed by combining the lists of all the sponsors. This cross-sponsor group must have a clear picture of how all of the decision units might benefit the Army's effectiveness. Their job is to provide a benefit scale for a small subset of all of the decision units. The subset includes one item from each of the sponsor's lists, and the benefit scale provides the information necessary to collapse all of the individual sponsor benefit scales onto one scale. It is this cross-sponsor elicitation of benefits that moti-

PROCUREMENTS	COSTS ($)	ORIGINAL BENEFITS	FINAL (NORMALIZED) BENEFITS	BENEFIT / COST
A	16	100	100	6.2
B	36	99	83	2.3
C	56	95	80	1.4
G	35	70	72	2.1
D	9	90	58	6.4
E	30	87	37	1.2
F	20	83	30	1.5
H	26	70	19	0.7
I	2	60	15	7.5
J	1	55	8	8.0

Table 2-2

PROCUREMENTS – FINAL COMPARISONS

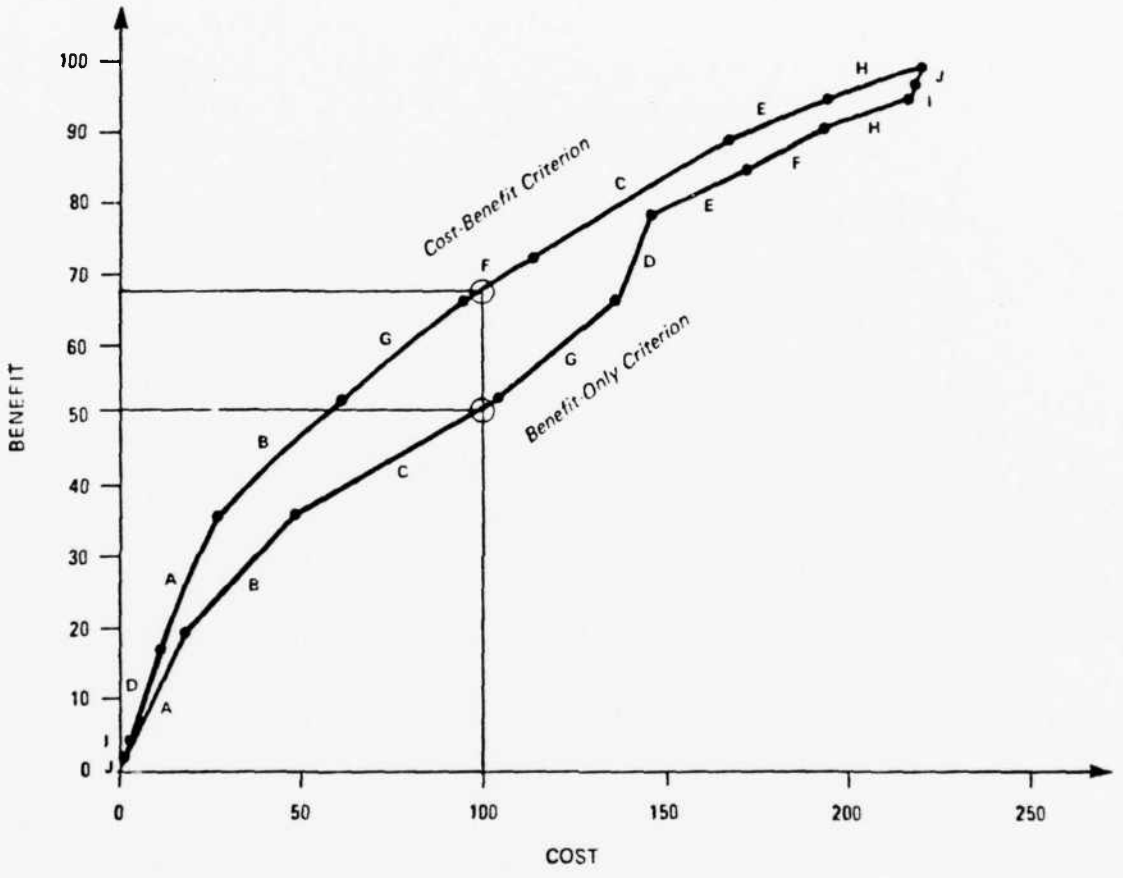

Figure 2-2

COST-BENEFIT VS. BENEFIT-ONLY CRITERIA: FINAL COMPARISONS

vates each sponsor to provide his true benefit estimates. After the final benefit scale is elicited, this group must provide supporting rationale. All of the rationale and numerical benefit scales provide the basis for the cost-benefit analysis and justification.

As an illustration of this cross-sponsor benefit scaling, consider the following two-sponsor example. Each sponsor, 1 and 2, has four decision units and has assigned benefits as shown in Figure 2-3. The cross-sponsor group is asked to compare "B" and "O" and decides that "O" is twice as beneficial as "B" (Figure 2-3). (Typically, there are eight to ten sponsors, and the iterative benefit assessment procedure described above for each sponsor is used.) This comparison between "B" and "O" provides enough information to rescale all of sponsor 1's decision units onto sponsor 2's scale. Since "B" must be a 15 on sponsor 2's scale, the 60 on sponsor 1's scale must be divided by 15, as must "A," "C," and "D." This is shown on Figure 2-4. If a sponsor contracts his benefit scale more than his true preferences would dictate, his programs may do poorly in the final analysis. For example, if sponsor 1 had claimed "B's" benefit was 90 rather than 60, his entire scale would have to be divided by 6 rather than 4 to be consistent with the belief that "B" is half as beneficial as "O".

The cross-sponsor benefit judgments are more difficult to make because the decision units are much more diverse. For this reason, the cross-sponsor group is asked to make two or three cross-sponsor scales, using different decision units from each sponsor's list each time. This is a way of triangulating on the problem that forces inconsistencies to surface. Finding the reasons for these inconsistencies and resolving them strengthens the final result so that it is more defendable.

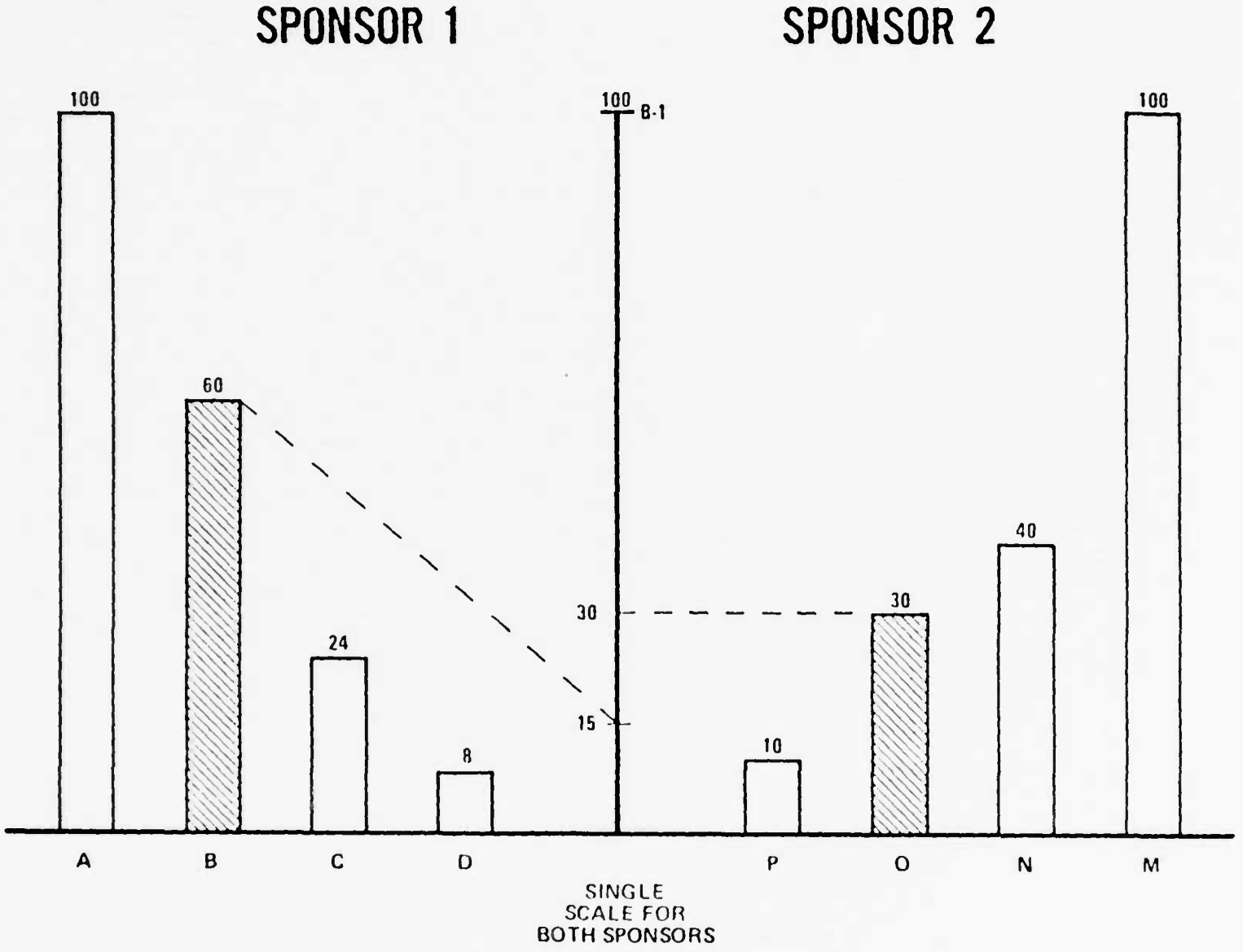

Figure 2-3. Cross-Sponsor Benefit Ranking

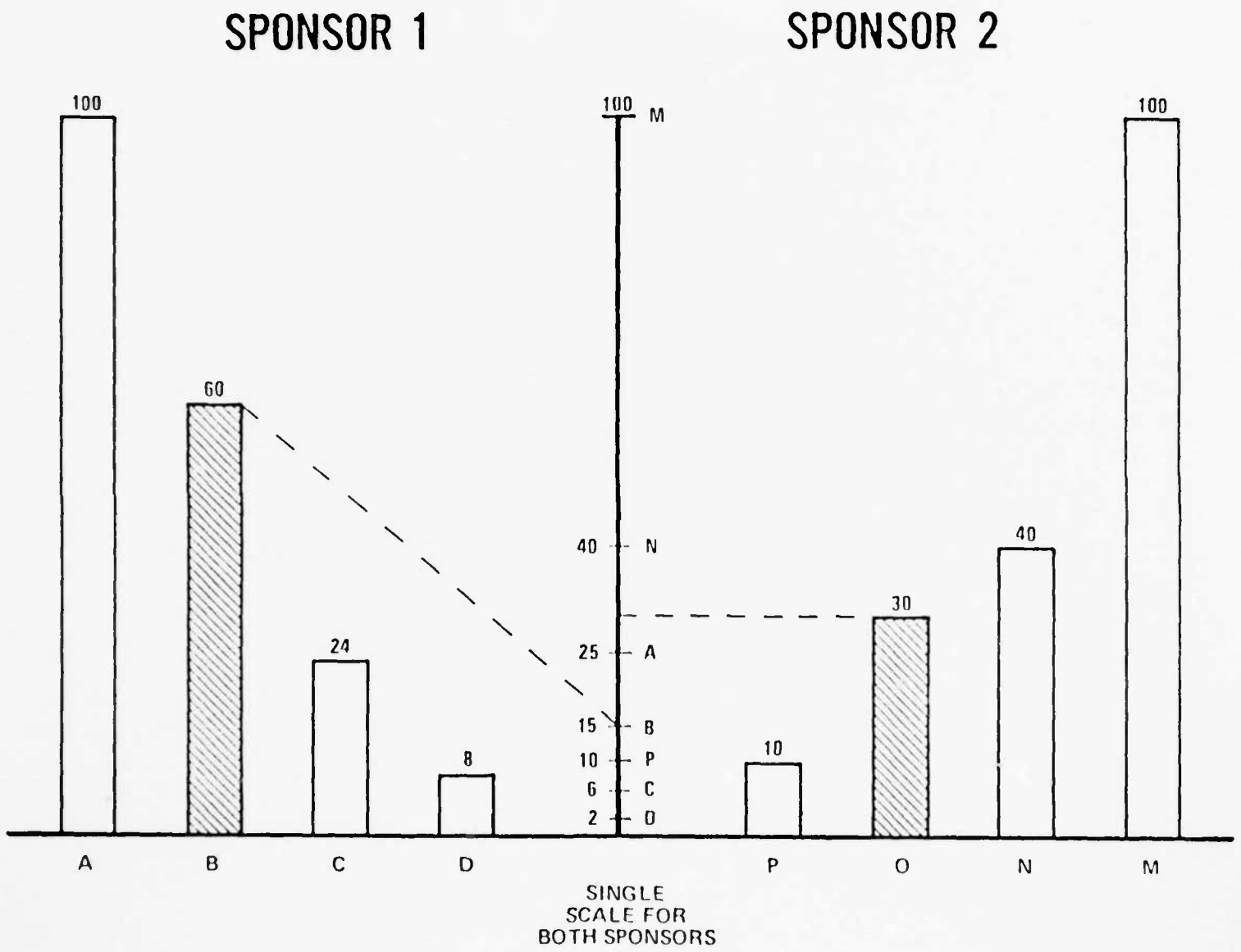

Figure 2-4. Two-Sponsor Benefit Scale

Once the final cross-sponsor benefit scale has been chosen, the relative benefits of all of the decision units are made explicit. All the programs have been scaled in terms of benefit on a corporate scale. Now the benefit/cost ratios can be calculated for each decision unit, and the decision units prioritized from most cost-beneficial to least cost-beneficial. The important characteristics are the way the process is structured and the defendability of the output.

2.2 Multi-Attribute Utility Theory for Mission Capabilities Analysis

A multi-attribute utility model is hierarchical in nature, starting with the specified top-level factor for which an overall evaluation is desired. This factor is successively decomposed into subfactors in descending levels of the hierarchy such that each successive level is more specific than the one preceding. At the lowest level of the hierarchy are predictable or observable technical (or other) characteristics of the system under evaluation. These lowest level, highly specific characteristics are typically system parameters. A characteristic of this decomposition is the appropriate level for each of the many players in this decision-making process.

Multi-attribute utility analysis (MAUA) has been used to assist the U.S. Army and Air Force in mission capability analysis. Currently, this methodology is in use by the U.S. Army at Fort Monroe as part of the Battlefield Development Plan. It was used by the U.S. Air Force and Army at Langley Air Force Base during the reconnaissance/surveillance mission area analysis (MAA). (MAUA has also been used in numerous system evaluations for the Army and Navy.)

The hierarchical model for the reconnaissance/surveillance MAA is depicted in Figure 2-5. Performance in the total mission is first broken into two environmental descriptors, weather and countermeasures (CM). The four environmental categories are day clear with low CM, night adverse with medium CM, day adverse with medium CM, and all weather with high CM. The four weather and three countermeasure categories were well defined and measurable. Next, the targets are classified as either mobile or fixed. Mobile targets include troops, tanks, trucks, etc. Runways, command and control posts, and missile sites are examples of fixed targets. For each type of target, zones representing the location of the targets with respect to the forward edge of the battle area (FEBA) are the next level of the hierarchy. The five zones for mobile targets are 0-5 kms back from the FEBA, 5-50 kms, 50-150 kms, 150-350 kms, and 350-1000 kms. The four zones for fixed targets are 0-100 kms, 100-350 kms, 350-700 kms, and 700-1000 kms back from the FEBA. In the next level of the hierarchy, the military purpose for the information, that is, battle management or the execution of weapons against targets, is specified. The level below this enumerates the quantitative and qualitative characteristics of the system. The two quantitative capabilities are the area coverage and frequency of coverage of the reconnaissance/surveillance systems. Timeliness, location accuracy, and detail are the three qualitative capabilities of individual systems. Each of these bottom-level characteristics is defined in a measurable way.

Value functions were constructed by the appropriate experts for each of the quantitative and qualitative capabilities for each possible combination of target, zone, and purpose, assuming a 1980 threat. These value functions were scaled between zero and 100 and were assumed to be independent of the four weather/countermeasure classifications.

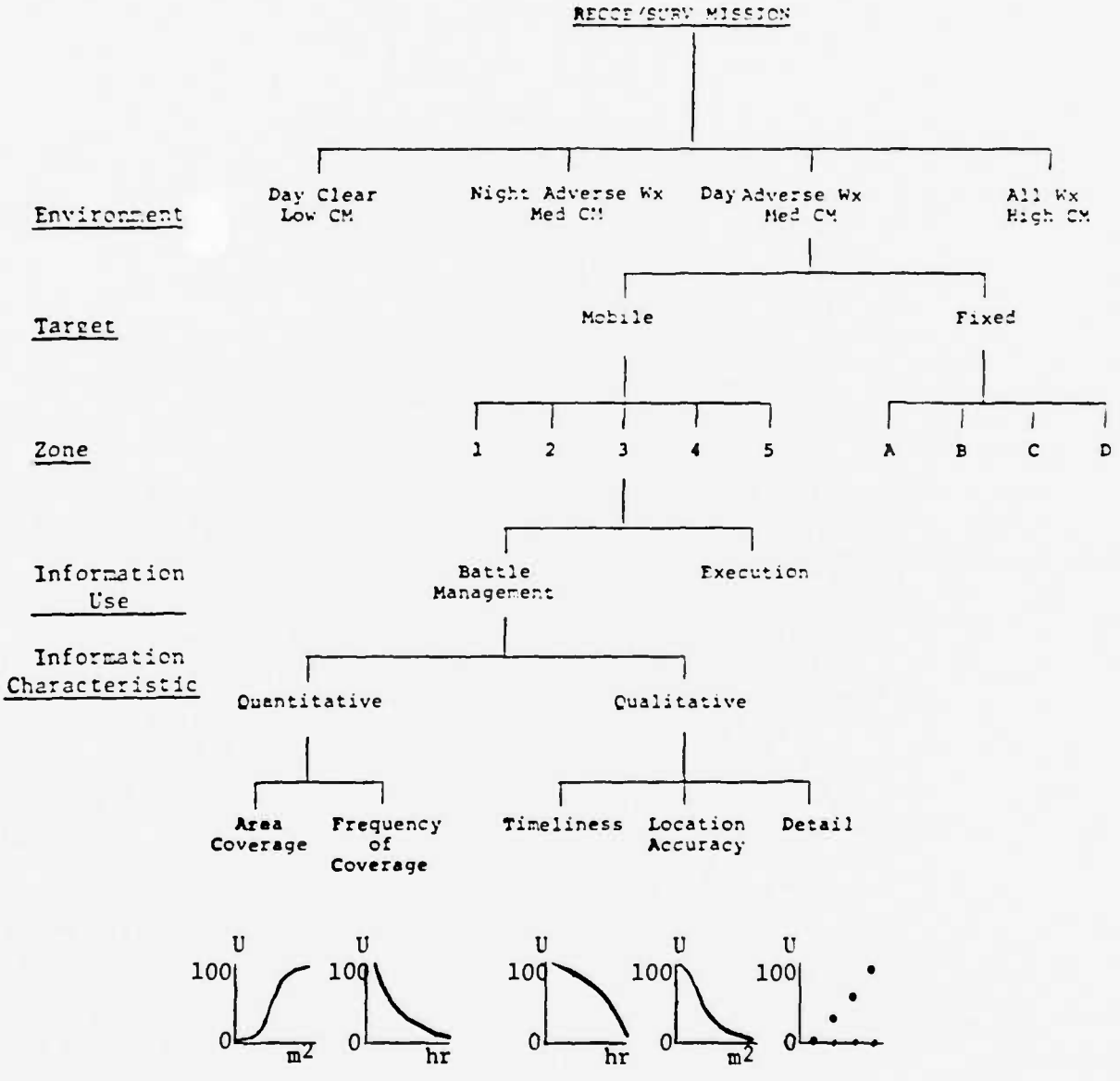

Figure 2-5. Multi-Attribute Utility Model for the Reconnaissance/Surveillance Mission

The value functions were developed by considering the percentage effectiveness of all current planning methodologies (battle management) or weapon systems (execution) for each value of a given characteristic, such as location accuracy. Therefore, for a given path through the hierarchy, the zero value for location accuracy is that accuracy that is not sufficient for any weapon system or planning purpose currently in use. The value of location accuracy corresponding in value of 100 is that for which all weapon systems or planning would be used to their optimum. The values between zero and 100 were scaled to the appropriate values of location accuracy representing the percentage effectiveness of management or execution. Examples are shown in Figure 2-5.

The importance weights for this hierarchical multi-attribute utility model are driven by the characteristics of the threat. So, for instance, the importance weights for zones one through five under mobile targets reflect the relative capabilities of the enemy's mobile military equipment in each zone. Likewise, the relative importance of battle management and execution in zone three for mobile targets determines these weights. These weights are also independent of the weather and countermeasure conditions. Experts at different levels of the decision-making process would be asked to assign the weights where their expertise applied.

The reconnaissance/surveillance MAA task force used this hierarchical structure to evaluate the current (1980) capability at all of the bottom levels. Initially, each reconnaissance/surveillance system was evaluated with this model in order to gain an understanding of the model and the systems. U.S. Army, U.S. Air Force (both tactical and strategic), European, and national systems were included. Then, a total system capability for each of the entry levels

to the model was defined that reflected such things as the number of each system in the field, the strengths and weaknesses of each, and synergisms between systems. Once these assessments were completed, judgments were made concerning the total 1980 reconnaissance/surveillance capabilities in each zone (both for mobile and fixed targets) for both the 1984 and 1994 threat and attack equipment.

Finally, the total deficiency in the reconnaissance/surveillance mission is defined as the unsatisfied need times the value of the need, summed over all of the MAA model's paths. The unsatisfied need is the difference in value between a perfect set of systems and the current systems. A perfect set of systems would score 100 points on each of the value functions in the model. The value of the needs is a function of the importance weights and is the value of going from a worthless (score of zero) to a perfect system. This numerical MAA model allows the task force to investigate all the elements of the mission where the critical deficiencies exist.

3.0 PRIORITIZATION APPLICATIONS

The cost-benefit methodology (Section 2.1) was applied to the prioritization of both the PARR issues and the program development incremental packages (PDIP's) for POM-80. This section describes these two applications, both of which are based on the theses that:

- Army does have a corporate mission value system;
- the benefit elicitation procedures can establish meaningful benefit relationships.

The Army should have a corporate mission value system for these benefit relationships because it has a corporate view of the threat. The set of attributes to be considered in assigning an overall benefit value were:

- Army goals,
- Army's force packaging methodology,
- Marginal increases in . . . mobility, sustainability, training, standardization, interoperability,
- Urgency of need,
- Existing levels of effort,
- Moral obligations,
- Morale, and
- Compliance with law.

These attributes were not exhaustive, but a set of attributes was specifically excluded from consideration. Examples of these are:

- o OSD directed program/actions,
- o Congressional interest,
- o National or regional economics,
- o Prior commitments.

Basically, then, the benefit numbers were to reflect the relative contribution of the decision units to the combat effectiveness of the Army. The political, economic, and other factors were excluded during the elicitation of benefits. These parameters do enter the process, but as the last step by the decision makers at the highest level. (This is discussed further in Section 5.1.)

This procedure will be applied during the budget process in August and September, and the application will be reported upon in Section 3.3 when completed.

3.1 Program Analysis and Resource Review (PARR) Issue Prioritization

3.1.1 Discussion of the PARR prioritization - The overall goal of the PARR prioritization was to rank (in a three-day period) 334 PARR issues by using the previously described cost-benefit methodology. Fifteen Army Staff analysts were the experts who specified the benefit numbers. These analysts were knowledgeable of the PARR issues and familiar with the six Army goal categories depicted in Table 3-1. The PARR issues were categorized by both command and functional categories.

1 READINESS:

11 NATO: INITIATIVES DERIVED EXCLUSIVELY FROM THE NATO MISSION

12 OTHER CONTINGENCIES: INITIATIVES THAT SUPPORT OTHER CONTINGENCIES AS WELL AS THE NATO MISSION

13 TRAINING READINESS: PROGRAMS THAT RELATE INDIVIDUAL PREPAREDNESS WHETHER IN THE TRAINING BASE OR IN OPERATIONAL UNITS

14 UNIT READINESS: CREW AND UNIT TRAINING; OTHER INITIATIVES THAT AFFECT THE ABILITY OF A UNIT TO PERFORM ITS DOCTRINAL MISSION

15 MATERIEL READINESS: PROGRAMS RELATED TO MAINTAINING PRESCRIBED OPERATIONAL READINESS RATES (OR)

16 FORCE READINESS: PROGRAMS THAT DEVELOP THE MEASURES REQUIRED TO IMPLEMENT THE READINESS GOAL

2 HUMAN:

21 RECRUITING: INITIATIVES TO ATTRACT AND ENROLL INTO ACTIVE AND RESERVE COMPONENTS CIVILIAN RECRUITMENT

22 RETAINING: INITIATIVES TO RETAIN QUALITY PEOPLE: EQUAL OPPORTUNITY, QUALITY OF LIFE SUPPORT; RECOGNITION; TELLING THE STORY

23 OTHER: OTHER PROGRAMS THAT DEVELOP THE MEASURES REQUIRED TO IMPLEMENT THE HUMAN GOAL

3 MATERIEL:

31 NATO: INITIATIVES DESIGNED TO IMPROVE RSI OF NATO FORCES.

32 OTHER ALLIES: INITIATIVES TO SUPPORT NATIONAL POLICY IN CONJUNCTION WITH OTHER ALLIED FORCES

33 SUPPORT: INITIATIVES AFFECTING THE SUPPLY AND MAINTENANCE SYSTEM FROM THE FIELD ARMY TO CONUS, INCLUDING HOST NATION CAPABILITIES

34 SUSTAIN: SUSTAINABILITY PROGRAMS, TO INCLUDE PRODUCTION BASE REQUIREMENTS, EQUIPMENT AND CONSUMABLES

35 RESUPPLY: RESUPPLY PROGRAMS (OTHER THAN DIRECTLY TO FIELD ARMY) TO SUPPORT ALL LEVELS WITH AMMUNITION, FUEL, REPAIR PARTS AND SUBSISTENCE

36 OTHER: PROGRAMS THAT DEVELOP THE MEASURES REQUIRED TO IMPLEMENT THE READINESS GOAL

4 STRATEGIC MOBILITY:

41 DEPLOYMENT: INITIATIVES RELATED TO DEPLOYMENT PLANS, ORGANIZATION, MARSHALLING, LIFT, OPERATING PROCEDURES AND RECEPTION PLANS ON ARRIVAL AT DESTINATION

42 POMCUS: PROGRAMS RELATED TO ACQUIRING TRANSPORTING, STORING AND MAINTAINING POMCUS STOCKS

43 OTHER: PROGRAMS THAT DEVELOP THE MEASURES REQUIRED TO IMPLEMENT THE STRATEGIC MOBILITY GOAL

5 MODERNIZATION/FUTURE DEVELOPMENT:

51 TECHNOLOGY: PROGRAMS THAT EXPLOIT NEW TECHNOLOGY TO ENHANCE RSI

52 TACTICS: PROGRAMS THAT SUPPORT DEVELOPMENT/REFINEMENT OF TACTICS/TECHNIQUES ASSOCIATED WITH NEW EQUIPMENT

53 DOCTRINE: INITIATIVES THAT RELATE TO DOCTRINAL DEVELOPMENT WITH OTHER SERVICES AND WITH ALLIES

54 EQUIPMENT: PROGRAMS THAT IDENTIFY REQUIREMENTS FOR NEW/IMPROVED/MODIFIED EQUIPMENT (INCLUDES MAINTENANCE, RESUPPLY AND INDIVIDUAL/UNIT TRAINING REQUIREMENTS DERIVED FROM INTEGRATED SYSTEMS APPROACH TO DEVELOPING NEW EQUIPMENT AND WEAPONS)

55 AUTOMATION: INITIATIVES RELATED TO DEVELOPMENT, ACQUISITION AND O&M OF INFORMATION SYSTEMS FOR THE TACTICAL AND SUPPORT ENVIRONMENTS

56 ORGANIZATION: INITIATIVES THAT APPLY TACTICAL/DOCTRINAL CHANGES TO ORGANIZATIONAL STRUCTURE

57 OTHER: PROGRAMS THAT DEVELOP THE MEASURES REQUIRED TO IMPLEMENT THE FUTURE DEVELOPMENT GOAL

6 MANAGEMENT:

61 BASE OPERATIONS: PROGRAMS RELATED TO INSTALLATION RESOURCE MANAGEMENT, INCLUDING AUTOMATION SECURITY

62 ACTIVE ARMY: INITIATIVES RELATED TO USE OF AND JUSTIFICATION OF END STRENGTH (REQUIREMENTS, FORCE STRUCTURE, SUPPORT PROCEDURES, HOST NATION SUPPORT)

63 RESERVE COMPONENTS: PROGRAMS DESIGNED TO IMPROVE THE MANNING, TRAINING, EQUIPPING, AND READINESS OF RESERVE COMPONENTS

64 CIVILIANS: PROGRAMS RELATED TO USE OF END STRENGTH AND INITIATIVES TO IMPROVE EFFICIENCY, SUCH AS CONTRACTING POLICIES

65 SYSTEMS: INITIATIVES RELATED TO SYSTEMS MANAGEMENT OF RESOURCES

66 OTHER: PROGRAMS THAT DEVELOP THE MEASURES REQUIRED TO IMPLEMENT THE MANAGEMENT GOAL

Table 3-1. Functional Categories

Prior to this prioritization, nearly 800 PARR issues underwent a Sieve Analysis during which the following PARR issues were removed from consideration: 1) Issues funded within basic levels of the major commands (MACOMs); 2) issues included in PDIPs; and 3) issues non-supported by the Staff. The result of this Sieve Analysis was the set of 334 PARR issues to be prioritized.

The first step in the prioritization was to establish a "marker" list of approximately 80 representative PARR issues. Table 3-2 is a categorization, by functional category and by command, of the 87-item marker list which was settled upon by the participants. For this analysis, the Material and Strategic Mobility categories were combined into one single category.

Having established the 87-item set of markers, the next step was to evaluate the benefits for each of the 19 subsets of marker items. This benefit assessment was done by command and within categories. For example, the EUR-KOR Command was required to establish benefits for its nine readiness items by first giving what was believed to be the most important single item a benefit of 100 and then adjusting the benefits of the other eight readiness items appropriately. The other commands similarly established benefits for their marker list PARR issues within each of their functional categories.

The next step in establishing the overall list of benefits for the marker list was to combine the marker items from each command into a single list for each functional category. To accomplish this task for each functional category, command analysts met and adjusted the benefits of a single highly beneficial item in each command to some mutually agreeable magnitudes. Next, items from the middle of each command's benefit list were mutually adjusted in benefit.

"MARKER" PARR ISSUES	Readiness	Human	Materiel	Moderniz'n	M'gmt
EUR-KOR	11	9	5		2
TRADOC-HSC	6	5		6	2
DARCOM	3	2	6		
FORSCOM	8	2	1		4
ACC	7	1		3	4
TOTAL	35	19	12	9	12

Grand Total **87**

Table 3-2

BREAKDOWN OF "MARKER" LIST

Finally, a similar adjustment was made for items ranking low on each command's benefit list. After the three adjustments, comparisons were made to see if they reflected the same benefit proportionality among commands. If not, readjustments were made both within and between command lists until a final between-sponsor proportionality was achieved. The remaining items in each command's category list were then rescaled to correspond with the new benefits for the previously rescaled items on each list. Each command's portion of PARRs for the designated category was directly integrated to form a single category marker list. The participants were allowed to review each integrated category marker list and alter the benefits until a level of indifference among combinations of packages was achieved. Any movement, however, required the mutual consent of the participants.

At this point in the analysis, there existed five separate marker lists, each corresponding to a different functional category. The next step in the analysis was to combine the separate category marker lists into an overall marker list. To perform this task, the relative magnitudes of the items with high, medium, and low benefit on each category marker list were adjusted. An iteration to establish consensus levels of indifference on these adjustments then took place, and the remaining items on the lists were then rescaled appropriately. The category marker lists were combined into the final overall marker list, and all participants were then given the opportunity to adjust the benefits of any items on the list. Once again, these adjustments could be performed only by mutual consent.

The cost-benefit implications of the benefits assessed for the marker list were then calculated, and the participants were given the opportunity to once again adjust the benefits for these items. For the first time, the

real meaning (in a cost-benefit sense) of the benefit assessments surfaced, and as a result, some drastic changes in benefit assessments took place. (The chief problem uncovered with the first set of benefits was that the range of the benefit scale was much smaller than the range of the cost scale. Since most participants felt this to be untrue, the benefit scale was expanded. As always, benefit alterations were made only through mutual consent of all participants. The result at this point was a benefit scaling of all 87 marker issues. The successive iterations described above had converted an ordinal ranking to a numerical ratio scale of benefits. This benefit scale could now be compared to the cost scale so that a cost-beneficial prioritization could be established.

Table 3-3a, b contains the final listing for the marker issues sorted by benefit alone and by cost-benefit. Figure 3-1 contains a plot of cumulative cost versus cumulative benefit, based on the table. The lower curve in this figure assumes that items are purchased in order of benefit, highest to lowest; the top curve assumes purchasing in the order from lowest to highest cost/benefit ratio. The two plots clearly illustrate the tremendous gain in accrued benefit which results when the cost-benefit rather than the benefit-only purchasing strategy is used.

Before the prioritization continued into the phase of integrating the 247 remaining PARR issues into the marker list, the participants were asked to supply rationale for the relative placements of a portion of the marker items with respect to one another in the category marker lists.

The final step in establishing the benefit list was to integrate the 247 remaining PARR issues with those contained in the marker list. This integration was performed by functional category. That is, the remaining PARR issues

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ITEM		BENEFIT	C/B	COST	CUM COST
77)	U001 NBC DEF	1400.0	.9	1297	1297
55)	D094 CENT PROCM	1000.0	31.5	31834	33131
30)	U095 2 FLOAT PR	850.0	2.9	2456	35587
53)	F002 RAP REIN 2	825.0	19.6	16210	51797
1)	T026 CHILD CARE	700.0	.5	329	51826
46)	A019 WWMCCS EA	700.0	56.3	39488	91314
60)	T001 MPRL WTHR	689.0	16.3	11244	102558
84)	U093 CHAPT SHOP	630.0	2.9	1828	104386
42)	T074 NEW SYSTEM	620.0	28.3	17546	121932
15)	F004 FLY HR PGM	600.0	38.5	23100	145032
25)	U046 AMCSA 3	600.0	20.0	11994	157026
49)	T057 TSM	600.0	1.1	690	157716
14)	K001 P2 MSN	500.0	13.6	6779	164495
39)	D138 DEPOT MNT	500.0	242.9	121457	285952
54)	D142 SPLY DP OP	500.0	297.8	148875	434827
57)	U115 TANK UPGRD	500.0	6.7	3341	438168
96)	F003 RAP REIN 3	462.0	11.9	5505	443673
75)	U016 MAINT FACS	450.0	85.4	38415	482088
10)	U155 AF SP-MSF	420.0	6.2	2586	484674
28)	U020 NON-DIV EN	400.0	17.6	7053	491727
58)	U012 CENTAG STO	375.0	96.5	36176	527903
74)	U096 CONVERTERS	338.0	1.8	592	528495
81)	T058 JOB TNG PK	310.0	7.3	2262	530757
32)	U149 AN/TPQ-29	300.0	50.1	15021	545778
12)	U163 DIA BUSES	280.0	.0	0	545778
42)	T064 RES SCHOOL	275.0	10.1	2770	548548
31)	U150 NCOES	250.0	8.0	2002	550550
37)	D143 SUPPLY MGT	250.0	48.1	12025	562575
78)	K017 TRANSP SVC	248.0	4.5	1116	563691
7)	U098 LIBRARY OP	245.0	1.1	268	563959
23)	F128 USAR CO EQ	240.0	14.7	3518	567477
80)	T051 ADA THREAT	240.0	11.4	2731	570208
73)	U120 BOILER PLT	225.0	20.4	4606	574814
13)	F138 RACH HSG A	210.0	100.4	21078	595892
24)	F097 ADT LOGEX	210.0	2.5	524	596416
67)	A033 SFT TRITAC	203.0	3.0	600	597016
48)	D139 NEW EQP TR	200.0	23.0	4606	601622
2)	T055 ACS UPGRAD	182.0	1.2	219	601841
21)	F098 ARTS PROG	180.0	113.3	20392	622233
8)	U078 ACS CCF	175.0	56.0	9798	632031
60)	U082 JUP MAINT	175.0	12.9	2262	634293
66)	D158 MAINT ENGR	167.0	438.6	73241	707534
47)	A023 WIN	160.0	5.0	797	708331
77)	U114 MAINT ADP	158.0	1.6	260	708591
79)	K008 PERS SPT	158.0	10.5	1658	710249
25)	F101 USAR TNG D	150.0	43.3	6499	716748
33)	U111 GUARDRAIL	150.0	1.2	176	716924
52)	F001 RAP REIN 1	149.0	3.7	544	717468
48)	A026 ATC	140.0	10.4	1459	718927
84)	D149 PROJ MGMT	135.0	132.4	17873	736800
68)	A068 ATC 22 AAF	122.0	18.8	2296	739096
20)	F010 USAR AN TR	120.0	67.3	10480	749576
90)	A039 SPECOPS	120.0	.8	100	749676
76)	U053 MASTER PLN	113.0	6.4	721	750397
82)	F103 MSTR PLNG	113.0	52.2	5900	756297
9)	U154 CHAPEL EQP	105.0	2.5	262	756559
92)	H007 AUTOMATION	102.0	5.7	581	757140
29)	U126 ALO INC 4	100.0	13.3	1330	758470
61)	U116 MTRL MGT	100.0	5.3	526	758996
85)	D150 CENT SPLY	90.0	63.7	5731	764727
87)	D154 PROP DISP	90.0	589.9	53090	817817
62)	U143 AOAP	83.0	1.4	117	817934
83)	F130 RMAR-FORSM	79.0	149.4	11800	829734
72)	T114 SYS STUDY	72.0	27.8	2000	831734
93)	H016 MED EQUIP	72.0	19.0	1365	833099
18)	K018 MEDICAL	70.0	17.5	1227	834326
45)	T133 DH RENOVAT	69.0	43.5	3000	837326
64)	F084 MTRL MAINT	67.0	116.8	7824	845150
26)	F104 RC SPT TNG	60.0	84.2	5051	850201
99)	A062 AUTODIN 2	60.0	18.2	1093	851294
91)	A076 TECH CNTRL	60.0	26.8	1605	852899
5)	T132 KP RET/OST	56.0	191.0	10698	863597
14)	F140 RACH HSG R	56.0	267.9	15000	878597
34)	U121 IISS	50.0	84.9	4246	882843
50)	A063 SATCOM	50.0	73.8	3690	886533
17)	A072 MARS	49.0	62.6	3067	889600
22)	F083 LAND ACQ	45.0	16.7	750	890350
65)	D147 IND PREP	42.0	2266.0	95131	985481
51)	A064 ATCAP	40.0	52.0	2080	987561
6)	U162 MPL THTRS	35.0	12.9	452	988013
11)	U159 SETAF MUSI	35.0	11.3	397	988410
15)	D181 VOL ED PGM	28.0	1.7	47	988457
16)	D176 FHMA	28.0	122.1	3418	991875
81)	F092 ENERGY PGM	26.0	755.5	21145	1013020
71)	T094 BASE ENERG	23.0	203.1	4672	1017692
86)	D179 CIV ED	23.0	18.1	417	1018109
3)	TH62 DP ED PROG	21.0	11.0	232	1018341
69)	A040 OSHA-ACC	20.0	130.9	2617	1020958
4)	T063 DP PLASTIC	7.0	35.7	250	1021208
44)	T093 TNG ABLTY	7.0	1063.7	7446	1028654
88)	F091 OSHA-FORSM	6.0	2796.8	16781	1045436
70)	A002 OE-ACC	5.0	67.6	338	1045774

Table 3-3a. "Marker" Issues Sorted by Benefit

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	ITEM	BENEFIT	C/B	COST	CUM COST
12)	U163 DYA BUSES	280.0	.0	0	0
1)	T026 CHILD CARE	700.0	.5	329	329
90)	A039 SPECOPS	120.0	.8	100	429
27)	U001 NEC INT	1400.0	.9	1297	1726
7)	U098 LIBRARY OP	245.0	1.1	268	1994
99)	T057 TSM	600.0	1.1	680	2674
33)	U111 GUARDRAIL	150.0	1.2	176	2850
23)	T055 ACS UPGRAD	182.0	1.2	219	3069
62)	U143 ADAP	83.0	1.4	117	3186
77)	U114 MAINT ADP	158.0	1.6	260	3446
15)	D181 VOL ED PGM	28.0	1.7	47	3493
74)	U096 CONVERTERS	336.0	1.8	592	4085
9)	U154 CHAPEL EQP	105.0	2.5	262	4347
24)	F097 ADT LOGEX	210.0	2.5	524	4871
94)	U093 CRAFT SHOP	630.0	2.9	1800	6671
30)	U095 2 FLOAT BR	850.0	2.9	2454	9125
67)	A033 SPT TRITAC	202.0	3.0	600	9725
52)	F001 RAP REIN 1	149.0	3.7	544	10269
78)	K017 TRANSP SVC	248.0	4.5	1116	11385
47)	A023 WIN	160.0	5.0	797	12182
61)	U116 MTRL MGT	100.0	5.3	526	12708
92)	M007 AUTOMATION	102.0	5.7	581	13289
10)	U155 AF SP-MSF	420.0	6.2	2586	15875
76)	U053 MASTER PLN	113.0	6.4	721	16596
57)	U115 TANK UPGRD	500.0	6.7	3341	19937
41)	T058 JOB TNG PK	310.0	7.3	2262	22199
31)	U150 NCOES	250.0	8.0	2002	24201
42)	T064 RES SCHOOL	275.0	10.1	2770	26971
48)	A026 ATC	140.0	10.4	1450	28421
79)	K006 PERS SPT	158.0	10.5	1659	30080
3)	T062 DS ED PROG	21.0	11.0	232	30312
11)	U157 SETAF MUSI	35.0	11.3	397	30709
88)	T051 ADA THREAT	240.0	11.4	2731	33440
54)	F003 RAP REIN 3	462.0	11.9	5505	38945
49)	U082 JUR MAINT	175.0	12.9	2262	41207
6)	U162 AFL THTRS	35.0	12.9	453	41660
29)	U126 ALO INC 4	180.0	13.3	1330	42990
36)	K001 PC MSN	500.0	13.6	6779	49769
23)	F128 USAF CO EQ	240.0	14.7	3518	53287
40)	T001 WRNL WTHR	688.0	16.3	11244	64531
22)	F063 LAND ACQ	45.0	16.7	750	65281
18)	K018 MEDICAL	70.0	17.5	1227	66508
28)	U020 NON-DIV EN	400.0	17.8	7052	73561
86)	D179 CIV ED	23.0	18.1	417	73978
69)	A062 AUTODIN 2	60.0	18.2	1093	75071
68)	A068 ATC 22 AAF	122.0	18.8	2298	77369
93)	M016 MED EQUIP	72.0	19.0	1365	78734
53)	F002 RAP REIN 2	825.0	19.6	16210	94944
35)	U036 ARCSA 3	600.0	20.0	11996	106940
73)	U120 BOILER PLT	225.0	20.4	4600	111540
38)	D159 NEW EQP TR	200.0	23.0	4606	116146
91)	A076 TECH CNTRL	60.0	26.8	1605	117751
72)	T114 SYS STUDY	72.0	27.8	2000	119751
83)	T074 NEW SYSTEM	620.0	28.3	17546	137297
55)	D094 CENT PROCM	1000.0	31.5	31534	168831
4)	T063 DR PLASTIC	7.0	35.7	250	169081
19)	F084 FLY HR PGM	600.0	38.5	23100	192181
25)	F102 USAR TNG B	150.0	43.3	6499	198680
45)	T133 DR RENOVAT	69.0	43.5	3000	201680
37)	D143 SUPPLY MGT	250.0	48.1	12025	213705
32)	U149 AN/TPQ-29	300.0	50.1	15021	228726
82)	K103 MSTR PLNG	113.0	52.2	5900	234626
51)	A064 ATCAP	40.0	52.5	2100	236726
8)	U079 ACS CCF	175.0	56.0	9798	246524
46)	A019 WWMCCS SA	700.0	56.3	39400	285924
17)	A072 MARS	49.0	62.6	3067	288991
85)	D150 CENT SPLY	90.0	63.7	5731	294722
78)	A092 OE-ACC	5.0	67.6	338	295060
50)	A063 SATCOM	50.0	73.8	3690	298750
26)	F104 PC SPT TNG	60.0	84.2	5051	303801
34)	U121 IISS	50.0	84.9	4246	308047
75)	U016 MAINT FACS	450.0	85.4	38415	346462
20)	F010 USAR AN TR	120.0	87.3	10480	356942
56)	U012 CENTAG STG	375.0	96.5	36176	393120
13)	F135 RACH MSG A	210.0	100.4	21078	414198
21)	F093 ARTS PROG	180.0	113.3	20392	434590
64)	F084 MTPL MAINT	67.0	116.8	7824	442414
16)	D176 FHMA	28.0	122.1	3418	445832
69)	A080 OSHA-ACC	20.0	130.8	2617	448449
84)	D148 PROJ MGMT	135.0	132.4	17873	466322
83)	F130 RMAR-FORSM	79.0	149.4	11800	478122
5)	T132 KP RCT/OST	56.0	191.0	10695	488820
71)	T094 BASE ENERG	23.0	203.1	4672	493492
39)	D138 DEPOT MNT	500.0	242.9	121457	614949
14)	F140 RACH MSG B	56.0	267.9	15000	629949
58)	D142 SPLY DP OP	500.0	297.8	148875	778824
66)	D158 MAINT ENGR	167.0	438.6	73241	852065
87)	D154 PROP DISP	90.0	589.9	53098	905163
81)	F093 ENERGY PGM	28.0	755.5	21175	926338
44)	T093 TNG ABLTY	7.0	1043.7	7306	933756
65)	D147 INP PREP	92.0	2266.2	95181	1028937
89)	F091 OSHA-FORSM	6.0	2796.8	16781	1045718

Table 3-3b. "Marker" Issues Sorted by Cost-Benefit

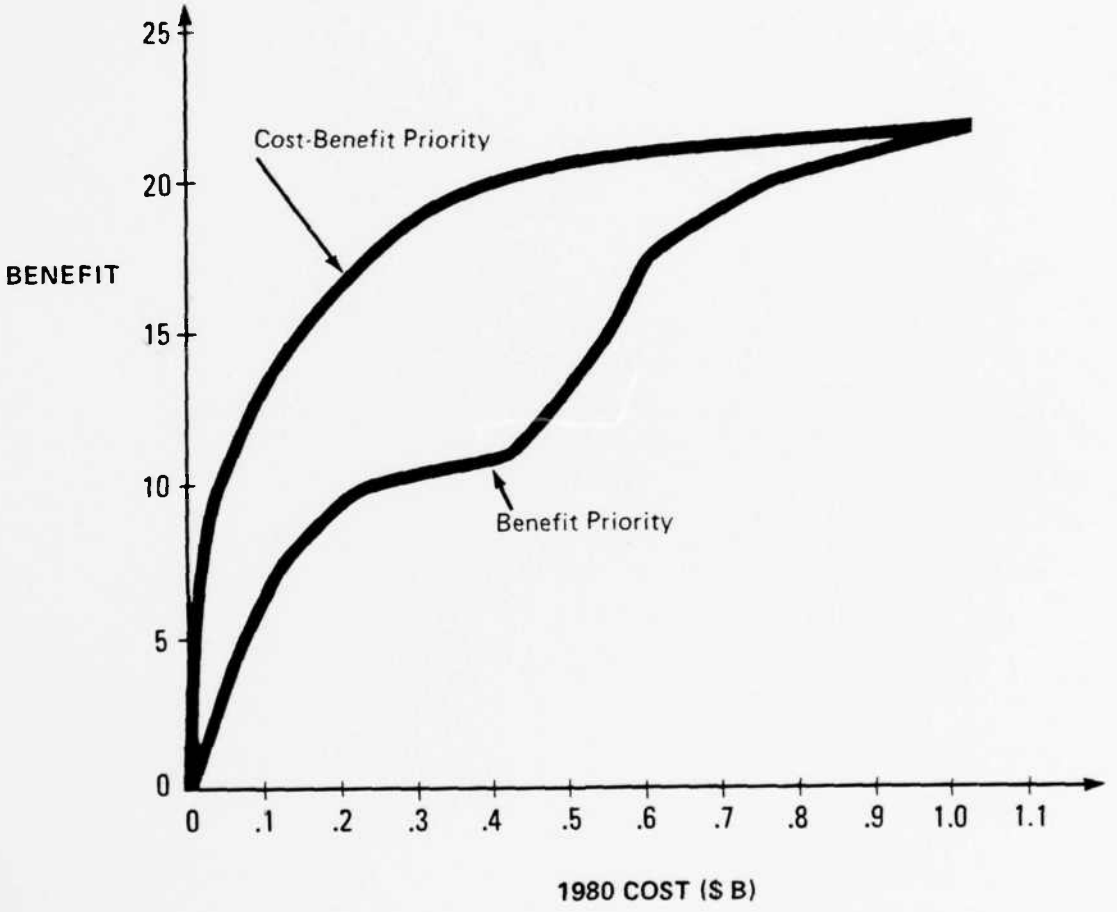


Figure 3.1

Cost-Benefit versus Benefit-Only Criteria--
PARR Issue "Marker" List

for each functional category were compared with issues of the same functional category in the marker list and assigned benefits. Hence, this process produced five separate lists of PARR issues (one for each functional category) whose benefits had been assigned on a common scale.

Before integrating these five lists into a final overall benefit list, the benefit lists by category were rank ordered with respect to benefit and cost-benefit. The costs assessed were the FY 80 costs in thousands of dollars. The participants were then allowed to study the implications of these lists in terms of purchasing priority, and to adjust benefit values which led to seemingly inappropriate implications. All adjustments were performed only by mutual consent among participants, and supporting rationale was provided.

The final step in the exercise was to combine the category benefit lists into a total PARR issue list. Although cross-referencing among the five category lists could provide the same amount of information, one single overall list made it easier to perform a final validation of benefit values and their implications. In this final iteration, benefit values could once again be adjusted by mutual consent of participants. The final overall benefit list could be used to establish buying priorities for all PARR issues across all functional categories.

Figure 3-2 displays, for the overall list of 334 PARR items, the cumulative cost versus cumulative benefit for both benefit only and cost-benefit purchasing strategies. Once again, this display makes overwhelmingly clear the tremendous advantage in terms of benefit-purchasing power to be gained from the cost-benefit versus the benefit-only purchasing strategy.

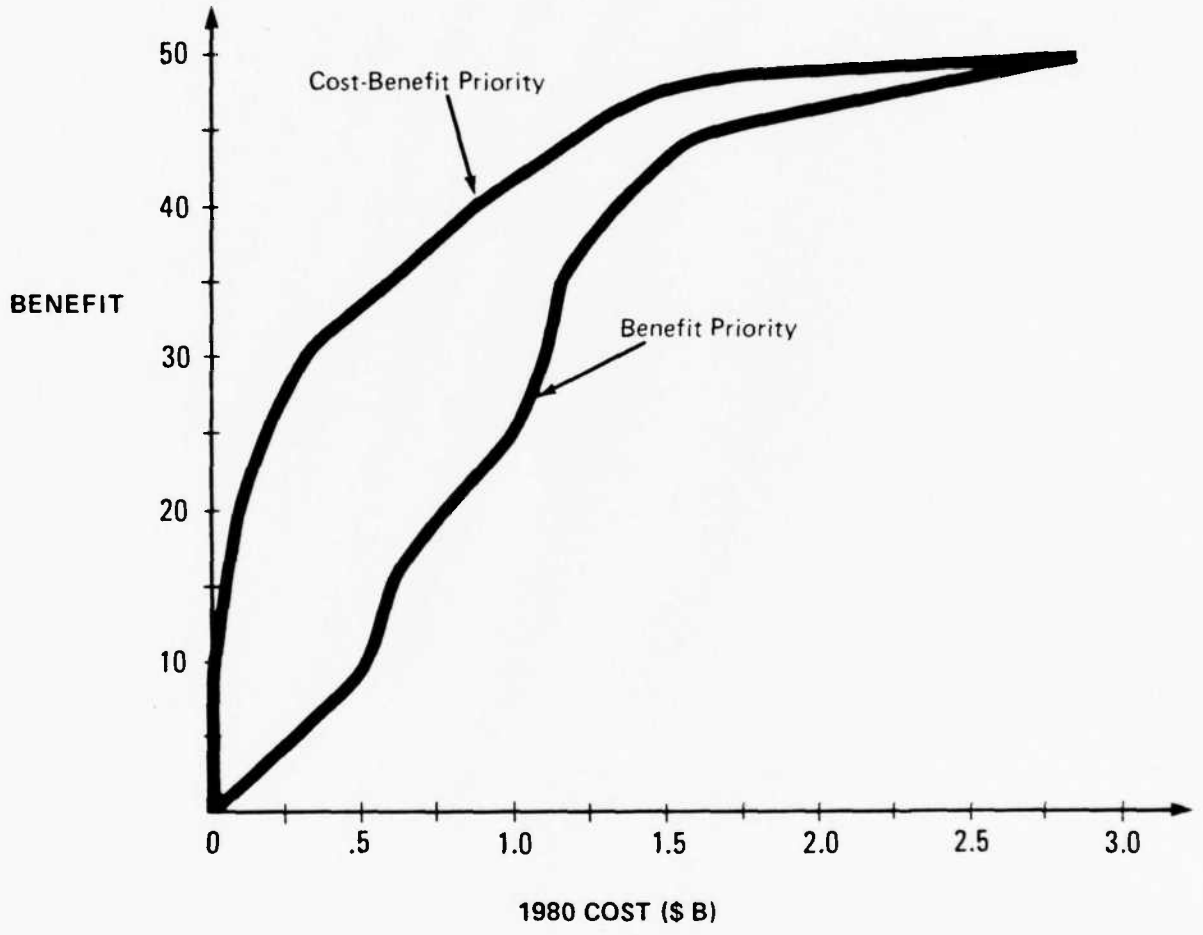


Figure 3.2

Cost-Benefit versus Benefit-Only Criteria--
PARR Issues

The final results of this PARR issue analysis and prioritization were an overall list of PARR issues ordered by benefit, an overall list of PARR issues ordered by cost-benefit, and a set of supporting rationale for the marker issues.

Before blindly accepting these data and using them to guide PARR-issue spending decisions, one should note several cautions. First, the benefit assessments are subjective and represent no more or less than highly knowledgeable but nonetheless fallible, analysts' judgments. Second, the cost data used in the analysis included only one-year costs, and manpower costs were not included in the PARR data. In addition, manpower constraints were not considered in assessing costs or benefits. Finally, the entire analysis was performed in an exceedingly short (three day) period.

In spite of the above limitations, this analysis nevertheless has a number of strong points and potential uses. First, the analysis supplies a sound starting point in the decision process on the PARR issues. Second, the cost-benefit consequences are clearly visible, and the process used in deriving them is a visible and reproducible one. Third, the analysis can be used as a communication aid, both in bringing into focus contentious PARR issues and in building a defense of PARR issues in the overall Army program development.

3.1.2 Rethinking the PARR drill - The PARR drill can be looked upon as a largely successful effort during which all involved personnel made optimal use of the short period of time allotted to them. In the future, this exercise should be allotted at least a full week, and the following steps should be followed:

1. Prior to the exercise, common task-specific definitions should be established. This would ensure that similar items from the various commands appear in the same functional categories.

2. An education period should precede the exercise during which -

   a) All PARR issues are clearly explained and understood; this includes all issues, not just potential marker list issues.

   b) Concise descriptions, in terms of "output" are written for all issues.

   c) The cost data are organized and validated.

3. The Army staff should select the marker issues and verify that they cover the full range of costs and benefits (functional category priorities).

4. The Army staff should develop benefit values for marker items with each functional category. As a rule of thumb, the benefit values should have roughly the same range as the costs of the issues.

5. The staff should provide the marker lists to PAE, and PAE should integrate the separate marker lists into a single master marker list.

6. The staff and PAE should convene to resolve master marker list priorities.

7. The master marker list priorities should go before the PGRC for approval.

8. The staff should develop benefit values for all issues in each functional category and integrate these into the category benefit lists.

9. The staff should provide the total integrated issue lists, by functional categories, to the PAE for integration into the final, total prioritized issue list.

If the above-suggested sequence of steps is followed, the PARR prioritization drill should provide maximum information to those individuals engaged in decision making with respect to PARR issue expenditures.

3.1.3 Inter-expert reliability - Since the relative benefit numbers that are used in the cost-benefit analysis are the result of careful expert judgment, the question of inter-expert reliability is often raised. That is, how much agreement can be expected between the benefit numbers of two qualified experts (or in the case of this type of exercise--two different groups of experts). This question has not been investigated under the controlled conditions of an experiment; although it certainly could be done. However, two independent benefit scales for 106 of the 334 PARR issues were developed. One of these scales was derived by the PARR issue prioritization that has just been discussed. The second scale was developed by individuals within seven directorates of DCSOPS. These individuals were briefed on the procedure by other members of DCSOPS so that the approach used for this prioritization was the same as that described in Section 2.1. Namely, each directorate developed a benefit scale for the PARR issues it sponsors and then the seven benefit scales were merged into a single scale. Figure 3-3 shows the agreement of these two benefit scales; each point representing the benefit numbers of the two groups for a single PARR issue.

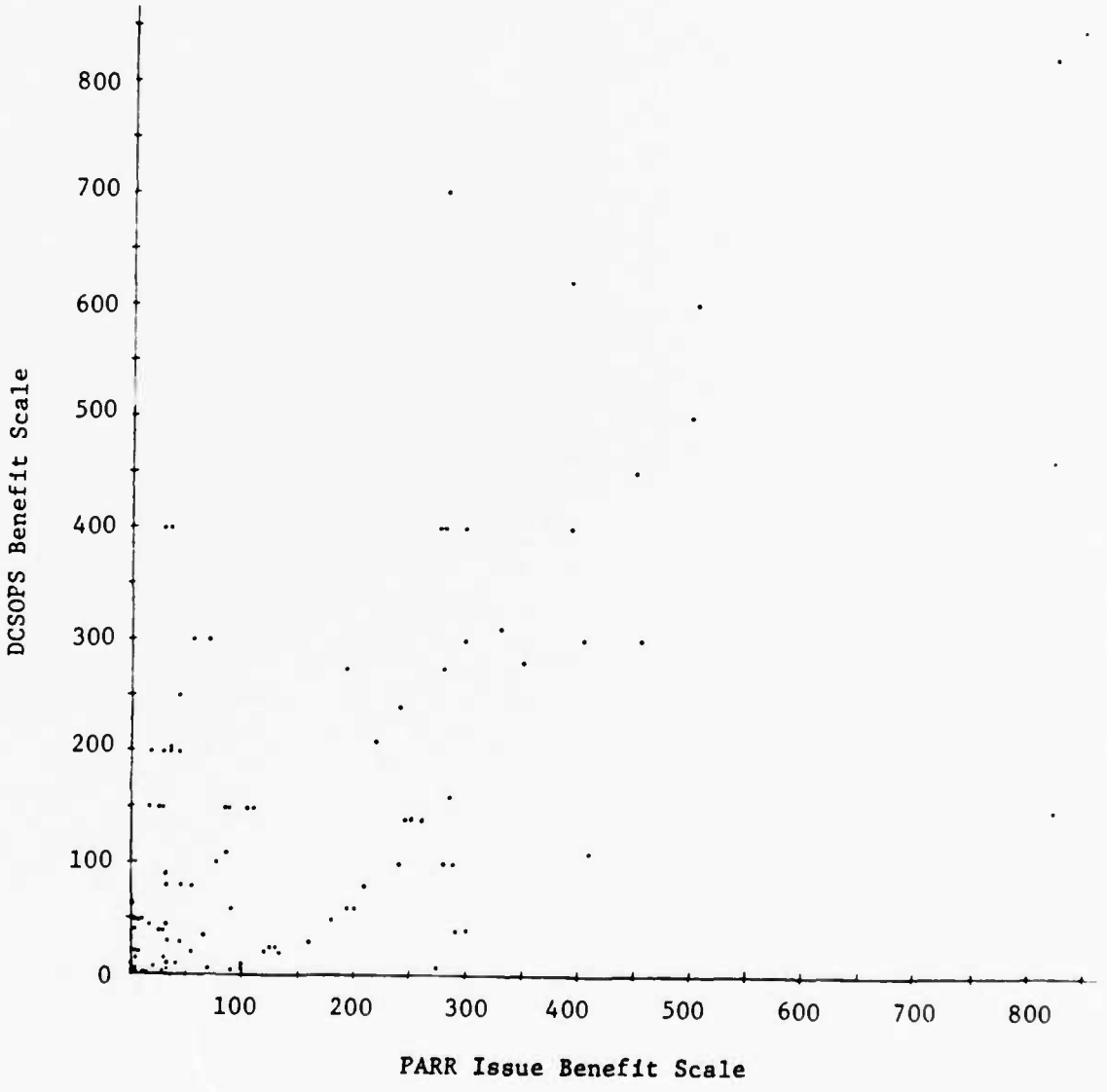


Figure 3-3. Inter-Expert Reliability

The correlation coefficient between these two scales is 0.70, which suggests significant though not striking agreement. It is likely that a controlled experimental investigation of inter-expert reliability produces results as good if not better than these.

3.2 POM Issue Prioritization

In the POM drill, a cost-benefit prioritization of all of the PDIP's being considered in the actual POM was developed--a total of about 185. There were ten sponsors or proponents:

1. DCSOPS — Deputy Chief of Staff for Operations
2. DCSRDA — Deputy Chief of Staff for Research, Development, and Acquisition
3. DCSPER — Deputy Chief of Staff for Personnel
4. OCAR — Office of the Chief of Army Reserve
5. NGB — National Guard Bureau
6. AAD — Army Automation Directorate
7. DCSLOG — Deputy Chief of Staff for Logistics
8. OCE — Office of the Chief of Engineers
9. PA&ED — Program Analysis and Evaluation Directorate
10. OTSG — Office of the Surgeon General

Clearly, the spectrum of PDIP's supported by these proponents is wide, as evidenced by the examples in Table 3-4. Summary

SPONSOR	PDIP TITLE
DCSOPS	National Training Center NATO Forward Deployed Readiness DS/GS Maintenance (USAREUR/FORSCOM) USAREUR DIV ALO Increase Flying Hour Program U.S. Contribution to NATO Military Budget
DCS RDA	M60 Tank Production GSRS REMBASS Air Cushion Vehicle (ACV)
DCSPER	Quality of Life Enhancement/ELIFE TAG No. 1 Women in the Army (WITA) Decision Package Set No. 40 Training Developments - Current Program Civilian Training, Education, and Development Program Organizational Effectiveness
OCAR	USAR Readiness (M to M + 30)
NGB	M to M + 30 Force
AAD	Readiness Automation Modernization Mobilization Automation Interoperability Project VIABLE, Phase 1 Automation Modernization I Automation Modernization II

Table 3-4. Representative Sample of PDIPS

SPONSOR	PDIP TITLE
DCS LOG	Support Readiness - Property Accountability NATO Task Force: Consumer Logistics
OCE	Training/Operational Efficiency - MCA Sub-Package Construction in Panama - MCA Sub-Package Korea Relocation - MCA Backlog of Maintenance and Repair - Europe
PA&ED	Readiness #1 (PARR's) Management #1 (PARR's) Modernization #1 (PARR's) Materiel #1 (PARR's) Human #1 (PARR's)
OTSG	Preposition 18 Reserve Component General Hospitals in Europe Military Occupational Health/Safety Hazards International Health Initiatives

Table 3-4. Representative Sample of PDIPS (Continued)

sheets for PDIP's prepared by the proponents contained a funding profile, narrative description, and rationale/analysis for the benefit numbers of the PDIP.

The PDIP's of AAD provide a useful illustration of the relative benefits ascribed by each proponent to his PDIP's. AAD's PDIP's are described in Table 3-5 in terms of five-year cost, relative benefit numbers, and benefit/cost ratio. With these costs and benefits, the cost-benefit priority order for AAD's PDIP's was:

1. Interoperability
2. VIABLE
3. Modernization I
4. Modernization II
5. Readiness
6. Mobilization
7. Modernization

This priority list was supported by AAD. The benefits reflect the following judgments:

- VIABLE is equal to the other six PDIP's in benefit.
- Interoperability is over twice as beneficial as the combination Modernization I and II, Readiness, Modernization, and Mobilization.
- Modernization II is slightly more beneficial than Modernization I, Readiness, and Mobilization.
- Modernization, Modernization I, and Readiness are more beneficial than Modernization II.
- Readiness is equal in benefit to Modernization and Mobilization.

PDIP	5-YEAR COST	BENEFIT	BENEFIT/ COST
VIABLE	147.	100.	0.68
Interoperability	30.	70.	2.3
Modernization II	35.	13.	0.37
Modernization I	18.	7.	0.39
Readiness	20.	5.	0.25
Modernization	232.	4.5	0.019
Mobilization	19.	0.5	0.26

Table 3-5. AAD's Relative Costs and Benefits

The benefit numbers for all of the sponsors were elicited over a two-week period by interacting with the action officers of each proponent.

Two cross-sponsor benefit scalings were assessed on a Saturday morning from the "Rump" PGRC (Program Guidance Review Committee). The rules of engagement for this cross-sponsor session are presented in Figure 3-4. These two scales contained a number of inconsistencies that were discussed with the "Rump" PGRC and resolved the next Monday by the action officers. Table 3-6 provides an implied cross-sponsor benefit scale for one PDIP from each sponsor's list in Table 3-4. The implied benefit scale is derived from the final benefit numbers of this POM prioritization. A set of judgments similar to those discussed above for packages of AAD's PDIP's can be constructed for these cross-sponsor PDIP's.

Following the cost-benefit analysis, additional parameters discussed at the beginning of 3.0 were considered. The resulting deviations were both visible and quantifiable to the top-level decision makers. Thus, the impacts of political and other legitimate (non-mission) parameters are visible. This visibility provides the top-level decision makers with a means to grade their efforts.

Figure 3-5 presents a graphical comparison of the two prioritizations. The vertical axis represents accumulated benefit as PDIP's are bought by each prioritization. The horizontal axis represents accumulated five-year cost. At the decremented level of funding, the POM order accounts for only half the benefit that the cost-benefit order does. The POM order is very similar to the cost-benefit order between the decrement and basic levels. As a result, the POM order results in two-thirds the benefit of the cost-benefit order.

1. SPONSOR BENEFIT ORDER HAS BEEN SET BY THE SPONSOR AND DOES NOT CHANGE DURING CROSS-SPONSOR ASSESSMENT.

2. SPONSOR MAY CHANGE BENEFIT NUMBERS ONLY TO RESOLVE INCONSISTENCIES.

3. INCONSISTENCIES CAN BE RESOLVED BY CHANGES IN CROSS-SPONSOR BENEFIT ASSESSMENTS (ITERATIONS 1 AND 2) AND/OR SPONSOR BENEFIT ASSESSMENTS. GROUP DELPHI TECHNIQUES WILL BE USED TO MAKE CHANGES IN CROSS-SPONSOR BENEFIT ASSESSMENTS. THE SPONSOR WILL BE SOLELY RESPONSIBLE FOR CHANGES IN HIS BENEFIT ASSESSMENTS TO RESOLVE INCONSISTENCIES.

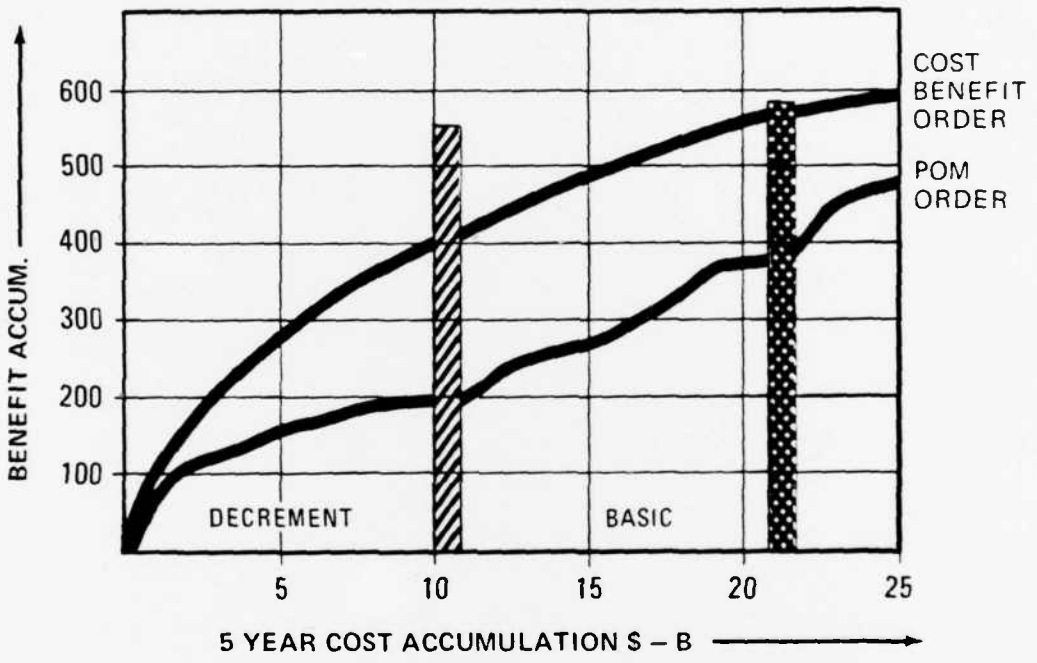
4. SPONSOR HAS SOLE RESPONSIBILITY FOR HIS PDIP STATEMENTS OF RATIONALE AND ANALYSIS. SPONSOR MAY CHANGE HIS STATEMENTS TO RESOLVE INCONSISTENCIES.

Figure 3-4. Rules of Engagement for Cross-Sponsor Benefit Scaling

SPONSOR	PDIP	CROSS-SPONSOR BENEFIT	5-YEAR COST	BENEFIT / COST
PA&ED	Readiness #1	100	134	.75
OCAR	USAR Readiness (M to M + 30)	81	165	.49
DCSOPS	DS/GS Maintenance	80	114	.70
NGB	M to M + 30 Force	79	552	.14
OCE	Construction in Panama	63	30	2.1
DCSPER	ELIFE	59	136	.43
AAD	VIABLE	34	147	.23
DCSRDA	M60 Tank Production	16	317	.050
OTSG	18 R.C. Hospitals - Europe	5.3	24	.22
DCSLOG	NATO T.F.: Consumer Logistics	2.5	66	.038

Table 3-6. Cross-Sponsor Benefit Scale

PROGRAM EVALUATION



Deviations . . . due to

- SOME OSD DIRECTED INITIATIVES
- MUST PAY BILLS
- PROGRAM IMBALANCE

Figure 3-5
COMPARISON OF POM WITH COST-BENEFIT ORDER

Several reasons for these differences are also listed in Figure 3-5.

Since OSD-directed initiatives, program imbalance, and so on are facts of life, this POM prioritization was represented to the decision makers as a good place to start but not the final answer. Reasons for this recommendation are:

- Benefit numbers represent only the Army's effectiveness. Other attributes involving political, economic, and other issues must be considered.
- Some of the PDIP's were dependent upon one another, such as the (1) creation and (2) deployment of a major unit.
- Only the five-year POM costs were used. Abnormally high outyear costs of certain PDIP's should be used to reduce their priority.
- Manpower constraints have to be considered in the final prioritization.
- This analysis is only conducted at the margin and therefore, does not flush out "gold watches" (soft programs) in the core.

Additionally, this cost-benefit prioritization was used by the decision makers to determine how to spend $189M that had not been specifically earmarked in FY 80 in the basic level that had been built into the initial POM prioritization. This enabled the decision makers to move the POM priority order closer to the cost-benefit prioritization.

3.3 Rethinking the POM Prioritization

There are three major areas where better planning can significantly improve this process. They are: (1) packaging the decision units, (2) determination of costs, and (3) benefit elicitations.

3.3.1 Packaging the decision units - Improving the packaging of decision units involves several issues. First, the decision units must be structured independent of one another in terms of benefit and cost. Adding a force structure element and deploying that element should not be in separate decision units.

Next, the elicitation of benefits requires that the appropriate people be familiar with each issue. Although this was generally true for most of the PDIP's that were considered for POM-80, it was not true for the PARR PDIP's or others which contained numerous disparate items. Since the Army is such a large organization and the aggregation of decision units is necessary to have efficient management, the packaging of decision units should be a hierarchical process. As one organizational element receives decision units from several lower level elements, it repackages the decision units using cross-element benefit numbers and the information provided by the lower elements about their decision units. This structure already exists within the Army staff; the problem is determining the best way to make it work for this process. Clearly, this process must be started early (October or November), with the publication of the draft Army Planning Programming Guidance Memorandum. This document provides uniform guidance on the decision process to the organization. Improved packaging structure should preclude the haphazard formulation of PDIP's as well as ensure that items within a PDIP are similar in cost-

benefit so that some soft programs do not get a "free ride" with good programs.

If, in future years, the POM analysis is going to be done at the margin, as was done this year, identifying exactly what is in the core and communicating this to the appropriate elements of the hierarchical organization is a third point that needs improvement. This has two beneficial aspects. First, this information is useful to the sponsors and cross-sponsors in assigning benefits because it helps define exactly how the Army will be different if a given PDIP is funded. Most of the PDIP's were tips of icebergs, the remainder of the iceberg being located in the core. It is important that people know the relative utility of the visible portion contained in the PDIP. Secondly, this close examination of the core is the best method for uncovering soft programs.

3.3.2 Determination of costs - The determination of costs includes two aspects. First, the five-year POM costs were used as the cost of the PDIP's this year when the incremental life cycle cost should have been used. The benefits of a PDIP corresponded to the life cycle benefit associated with the tip of the icebert defined by that PDIP. Therefore, the life cycle cost associated with the tip of each iceberg should be used as the cost of that PDIP. Clearly, many of these costs will not be incurred until the 1990's and, therefore, estimates of them will be very soft. Likewise, there are indirect costs associated with many programs that should be factored in but are hard to estimate. These costs should be estimated and used in the cost-benefit prioritization, with the awareness that the priority location of the decision units with the softest costs can be identified as an issue and discussed at any point in the process.

Second, constant dollars are the appropriate dollars to use in calculating the life-cycle cost of the decision units. Then year or FYDP dollars overemphasize the importance of dollars in the future. Discounting constant dollars, on the other hand, underemphasizes the importance of dollars in the future.

3.3.3 Benefit elicitation - The elicitation of benefits should be done over a longer period of time than was given the sponsors and the cross-sponsor group during both the PARR and POM prioritizations. This can easily be accomplished with advanced planning, and a week or more is recommended for the PARR issues and two months (1 February - 1 May) for the POM prioritization. The major improvement to be made is the specification of a simple framework to replace the benefit attributes. This can be taken care of to some extent with mission capabilities analyses. These analyses will be most useful in developing priorities for the many icebergs, however, and not as useful for prioritizing the different-size tips of these icebergs. A simple structure of benefit attributes like that depicted in Figure 3-6 would be very useful to the sponsors and cross-sponsor group. This is just a suggestion that can and should be improved upon substantially.

3.4 Budget Decision Issue Prioritization

TO BE PUBLISHED

3.5 Advantages of the Cost-Benefit Prioritization

The cost-benefit procedures used in these applications should, in theory, lead to better resource allocation decisions if valid benefit and cost information is used.

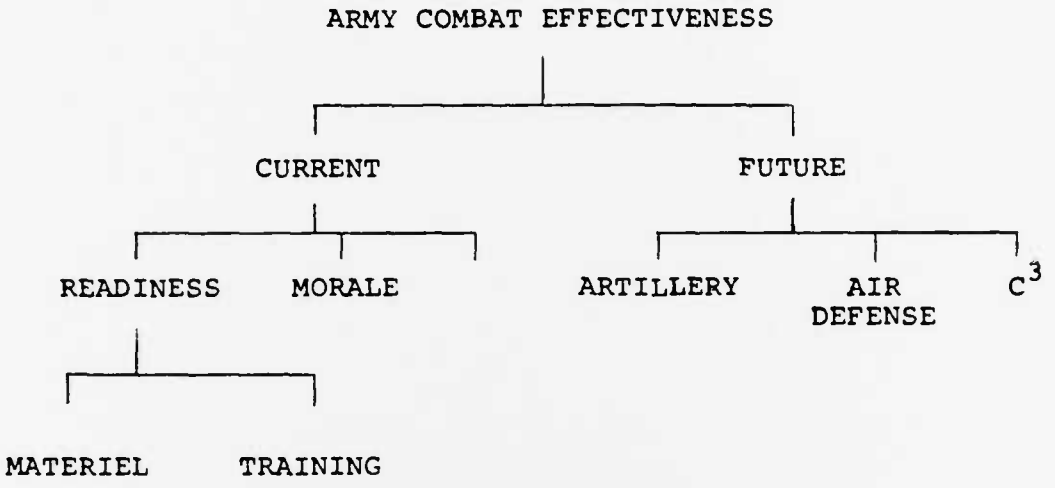


Figure 3-6. Benefit Attributes

3.5.1 Justification of POM recommendations - The systematic assessment process that generated the benefits and produced the cost-benefit ordering of PDIP's also produced discussions and information that supported and justified the quantifications of benefit. The sponsors used this information to write terse descriptions of the supporting rationale for the benefit numbers assigned to each PDIP. These descriptions can be used when others ask for clarification of the benefit scale. Additional attributes of this process are its responsiveness to requests for "what-if" analyses, and its adaptability to changes that may occur. The cost-benefit approach and the structure it imposes generates this responsiveness and adaptability because the theory dictates how changes are incorporated and what the resultant rankings of prospective procurements are. Questions about what procurements must be eliminated in order to fund others can be easily and effectively answered.

3.5.2 Availability of interactive computer support - An IBM 5100 mini-computer is programmed to do most of the calculations and data storage, retrieval, and manipulation needed by the working group responsible for preparation of the POM. The software in this computer is interactive in the sense that the officers responsible for POM preparation can use it after a very short instructional period without the assistance of a computer programmer. They can make changes to the data and ask for new displays/printouts at their own convenience without relying on others or waiting in the queues often associated with large computer systems. Their turn-around time is on the order of minutes or hours, and they can take the computer to meetings and briefings with them. This gives the officers a high level of confidence in the output of the computer because they are controlling the inputs and the computer processing themselves.

3.5.3 Identification of critical decision areas - The cost-benefit approach also facilitates the rapid identification of the real decision points; that is., that subset of PDIP's in the "gray area" of the decision-making process quickly surfaced. Consequently, most of the subsequent discussion can be focused on the troublesome subset rather than spread evenly across all the PDIP's.

4.0 MISSION CAPABILITY ANALYSIS APPLICATIONS

"TO BE PUBLISHED"

5.0 COMMENTS

5.1 Deviations from the Cost-Benefit Prioritization

As we discussed in Section 3.2, there are reasons for the Army to deviate from the cost-benefit priority. These reasons include:

- OSD Directives,
- Must-pay bills (these should be scrubbed thoroughly),
- Program imbalance,
- Manpower constraints,
- Congressional priorities,
- Production line considerations,
- Prior commitments (these should be scrubbed thoroughly),
- National and regional economic implications.

The recommended approach then is to first develop the cost-benefit prioritization by using Army effectiveness as the definition of benefit. Then, those decision units that are impacted by the above considerations should be identified as issues and moved up or down the priority list on an issue-by-issue basis.

5.2 Managing the Continuum

Managing the continuum embodies several issues, all having to do with focusing on the life-cycle nature of programs. First, the decision makers must address how well the programs meet the need in the future, as well as currently, and how supportable they are in the future, as well as currently. This means focusing on the life-cycle costs and benefits, not just the current costs and benefits.

This dual focus on the present and the future must carry over between the POM and Budget. Since the budget process has to focus narrowly on 1980 costs, it is easy to downplay the importance of outyear costs, as well as benefits. The POM process should be organized well enough to be usable in the budget process so that the life-cycle focus is not lost. The POM to Budget handoff necessitates a change in language and managers; this provides the perfect opportunity for disconnects and improves the chances that the budget process will focus narrowly on the budget year rather than the continuum.

5.3 Decision Tracking

Decision tracking is a mechanism for providing feedback to the decision makers concerning the impact of the resources they have allocated. Army decision makers are now making decisions for a budget in FY 80. Concurrently, the FY 78 budget is being spent, and the President and Congress are changing and approving the FY 79 budget. However, these decision makers are not receiving good feedback about the impacts of the funds expended in FY 77 and FY 78. The establishment of a mechanism to provide the right amount and detail of feedback to the appropriate decision makers is necessary to improve the concept of cost and mission benefit when developing future POM's.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The cost-benefit prioritization process based on decision-analytic techniques uses the current staff organization without requiring any adaptations. In fact, the process is nothing more than a highly disciplined staff action using the relevant expertise of each staff element.

This prioritization process has not been developed and tested within the Army. Plans have been formulated to apply this process during the analysis and prioritization of budget issues. In addition, this process is applicable to other Army resource allocation procedures and committees (such as the RDAC, CRRC, SIPC, and BRC). Other decision analytic techniques could well be applicable at other decision-making levels within the Army and should be investigated.

The general reaction of the action officers and general officers to the prioritization drill has been positive. In fact, many would have preferred to abandon the POM priority list for the cost-benefit priority list, and then determine deviations as discussed in Section 5.1. The advantages of using the cost-benefit procedure are:

- POM is more justifiable and defensible because:
  - cost-benefit approach is fiscally responsible;
  - better rationale for the importance of the PDIP's is provided;
  - response time for "what-if" analyses is short;

- sensitivity analysis can be conducted easily.

o responsive computer support for management decision making is assured.

o identification of the critical decision areas is provided for:

  - attributes besides Army effectiveness can be factored in systematically;

  - PDIP's around the decremented, basic, and enhanced funding levels can be scrutinized.

The decision analyst involved in this process is a facilitator who provides a structure and expertise for quantifying the judgments of the content experts. The Army staff provides the many levels of this content expertise, the requirements of which parallel the current Army staff organization structure. This procedure provides a structure and a discipline for the expertise of all elements of the Army staff.

6.2 Recommendations

The success of the cost-benefit prioritization procedures described in this report indicates that these analytical techniques should be codified and adopted as the Army prioritization system. Our recommended course of action for accomplishing this is the following:

(1) The DCSOPS should determine the macro parameters involved in codifying the process.

(2) The Force Packaging Methodology and Army Goals should be used as the initial framework into which this process is instituted.

(3) Improvements to this framework should be derived from both experience with the process and the results of total mission capabilities analysis as described in Section 2.2.